

Speech based Human Machine Interaction system for Home appliancesMayur Katore¹, Mrs. M. R. Bachute²¹E&TC Department, G.H. Raisoni Institute of Engineering & Technology, Pune²E&TC Department, G.H. Raisoni Institute of Engineering & Technology, Pune

Abstract —*This Human-machine interaction technology is a critical aspect for the way human use machines and recent advancement in technology made possible the development of Human-Machine interaction in new directions, especially in Speech based HMI systems. Lots of research is going on for the development of better speech recognition systems but very less efforts are made to develop speech based HMI system for common people. This paper presents an innovative integrated architecture by using Android enabled device, Bluetooth technology, MATLAB computing platform and advanced microcontroller to develop a Speech based HMI system for home appliances. The proposed system is affordable, flexible, user configurable, and user friendly therefore it can stand as very effective speech based HMI system for everyday real world applications.*

Keywords- *Bluetooth technology, Human-computer interaction (HCI) systems, Human Machine Interaction (HMI) systems, Hidden Markov model (HMM), MATLAB, Speech recognition, Speech commands.*

I. INTRODUCTION

Machine or any computing device can provide productivity, comfort and convince to user only with proper human-machine communication and so Human-Machine interaction (HMI) which defines the way human interacts or uses these machine or devices, have attract attention of many researchers and engineers in last few years [1]. Human -Machine interaction can be achieved by technologies based on touch, motion, Optic i.e. light, Sound or speech, or bionic [2]. A aim of any Human Machine interaction system is to enhance the interactions between users and machines by making machines more interactive and compatible to user's needs. HMI systems are designed such as to minimize the barrier between natures of human needs and the machine's understanding of the user's task [1].

As speech is the most natural way of communication in man-man interaction so speech based HMI systems have the potential to serve as most efficient way of human -machine interaction systems. Though there have been considerable achievements in the field of speech recognition by computers and machines like improvement in speech processing techniques, development of architectures for speech based HMI algorithms for learning and modeling, development of various models like Hidden Markov Model, and now even voice recognition chips like HM2007 are also available but very less efforts are made to develop speech based HMI systems for everyday use.

This paper presents a speech based HMI system for home by which user can operate and interact with home appliances and machines using speech. User will give speech command by android enabled device which conveys this command to programming unit through Bluetooth communication and then programming unit, which is interfaced with controlling unit, commands the controlling unit to operate devices according to program. The proposed architecture is very cost effective, user can configure the commands they which to use, and architecture is developed such as user and machine can interact like natural man-man interaction.

This paper is organized as follows; Section II gives some background on systems found in literature. Section III provides an overview of the elements involve in proposed system's development, and Section IV presents the implementation and working of a prototype. In Section V results and discussion are included, Section VI gives idea about future developments of the project while a final conclusion is drawn in Section VII.

II. BACKGROUND WORK

James Cannan et al [1] presented a literature survey of published papers in the area of Human Machine Interaction (HMI). They kept focus of this survey on state of the art technology that has or will have a major influence on the future direction of HMI. From their study they concluded that advanced HMI technologies will converge and combine functionality, to bring intelligent machines and robots more close to humans. Researchers at Bell Labs were the pioneers in development speech recognition technologies and HMI systems based on sound specifically human speech came into existence around 1950. Speech based Human-computer interface (HCI), which is similar to that of HMI systems, are being used in smartphones and computers. Karray et al [2] presented a paper which provides an overview of Human-Computer Interaction which includes the basic definitions and terminology, a survey of existing technologies and recent advances in the field, common architectures used in the design of HCI systems which includes uni-modal and multimodal configurations, and the applications of HCI. With the development of speech based HCI which are accurate enough to be employable for real world applications and are getting better and better indicates that now it is possible to develop speech based HMI systems which are employable for real world applications.

M. A. Anusuya et al [3] presents a brief survey on Automatic Speech Recognition and discusses the major themes and advances made in the past 60 years of research. They have summarize and compare some of the

wellknown methods used in various stages of speech recognition system and also discussed the concern that even after years of research and development the accuracy of automatic speech recognition remains one of the important research challenges (e.g. variations of the context, speakers, and environment). Saptarshi Boruah et al [4] discuss the basic overview of speech recognition system, the different variations, basic building blocks of this system, the algorithm behind the success of this system and the performance evaluation of the system. They gave a basic overview of HMM based speech recognition system, how does it actually work. Lakshmi Saheer et al [5] have included emotional parameters in audio to create an expressive speech for Human computer interaction. They have worked to develop automatic staging of audio with emotions which is also title of their work and their effort is to make human computer interactions as natural as possible. Moore et al [6] their work is developed from the results of recent study of neurobiology of living systems. Title of this research is "PRESENCE: A Human-Inspired Architecture for Speech- Based Human-Machine Interaction" and PRESENCE means PREdictive SENsormotor Control and Emulation, in which they present an architecture for speech based HMI where system understands user's need and intensions and vice versa. This work is being considered as very important for further study and development of speech science for technology and for development of various models for HMI which includes psychological and human spoken language behavior.

Mohammad et. al [7] develop an isolated-word automatic speech recognition (IWASR) system based on Vector Quantization (VQ), in which to extract features from speech signals, Mel-Frequency Cepstral Coefficients (MFCC) algorithm was used and Vector Quantization was applied for all feature vectors generated from the MFCC. Experimental results of this work concludes the recognition rate has been improved with the increase of database size and they achieved target of database size of 81 feature vectors which had a recognition rate exceeded 85%. Madhuri et. al [8] highlights the concept of eye and speech fusion in human computer interaction as human uses wide variety of senses to express or commands for variable activity. The proposed system considers mainly three modules which are as eye recognition, speech recognition and fusion, in addition to that different fusion techniques are applied on multimodal senses like eye and speech for certain desktop application. The eye recognition is processed using Kalman filter and 2d-measurement method under motion based approach and discrete wavelet transform (DWT) method is used for extracting speech features.

Now DSP processors are also being developed whose whole and sole function is to recognize voice, they are popularly called as "Voice Recognition Chips" like HM 2007 which provides high accuracy and these processors can be used by interfacing with suitable Microcontroller, it is very easy and convenient to develop speech based HMI systems using such Voice Recognition Chips. Carl et. al [9] propose an architecture for home automation by which user controls devices by employing a central Field Programmable Gate Array (FPGA) controller to which the devices and sensors are interfaced. Control is communicated to the FPGA from a mobile phone through its Bluetooth interface. The proposed architecture is very user friendly but the use of FPGA makes system expensive. Bader et. al [10] presents a wireless real-time home automation system based on Arduino Uno microcontroller as central controller developed with Matlab-GUI platform. The proposed system has two operational modes- Manual and self- automated. In self- automated mode controllers monitors and controls different appliances in the home automatically in response to the signals coming from the related sensors and in Manual mode the user can monitor and control the home appliances from anywhere over the world using the cellular phone through Wi-Fi communication technology. Use of Matlab for GUI makes system very flexible and reliable for user as well as developer. Thakur et al [11] developed a project of wireless home automation based on Zigbee communication technology which is controlled voice commands. For voice command recognition they have basically used a voice recognition chip (HM2007) with microcontroller and such HMI systems are mostly speaker dependent i.e. it works effectively for single speaker only. But HMI systems develop with these chips have limitations as these voice recognition chips very limited memory therefore such HMI systems can recognize only limited words and also user have to speak in a particular manner to operate such HMI systems.

III. SYSTEM DESIGN

The block diagram of the proposed system is shown in Figure 1. It consists of an android Smartphone, Matlab installed computing system (PC or Laptop) interfaced with Bluetooth module, and the ATmega8 microcontroller is interfaced computing system as well as home appliances.

3.1. Mobile Device

The system requires an android Smartphone device having a Bluetooth module and internet facility. The mobile is used for speech recognition via application which is developed using the java software. It is used for controlling the home appliances through speech commands which are interfaced with ATmega8 microcontroller. The mobile device communicates to its inbuilt Bluetooth module through an Application Programming Interface (API).

3.2. MATLAB Platform

The software implementation is carried out on Matlab platform so the proposed system requires Matlab installed PC or Laptop. Main program consists of code for Graphical-User interface (GUI) which is coded for manual mode useful for analysis of system and devices while another mode is automatic mode which operates appliances according to speech command. Code for user configurable dictionary of speech commands is written separately. Dictionary can be configured

by user for speech commands to be recognized by system according to which system will operate devices. in this heading, they should be Times 10-point boldface, initially capitalized, flush left, with one blank line before, and one after.

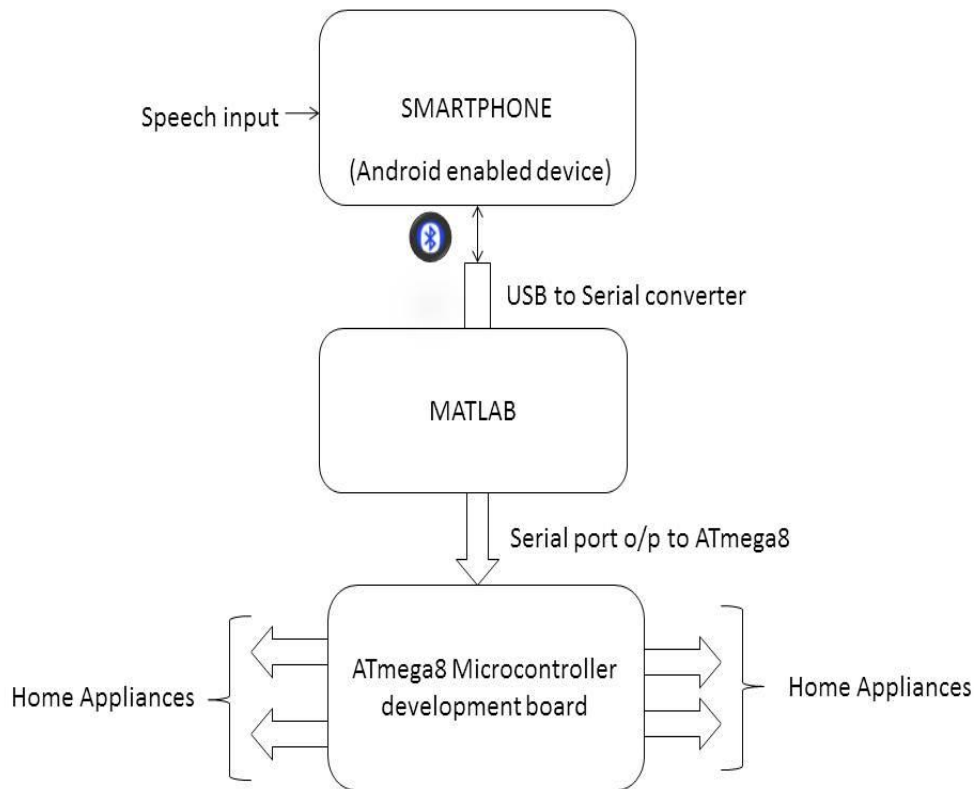


Figure 1. Proposed system's block diagram

3.3. Bluetooth communication technology

To establish communication between Android enabled smartphone and computing system is accomplished using Bluetooth module through a serial interface. Bluetooth technology was selected over other communication techniques as it is available in most mobile phones, can be implemented with low cost, consumes low power, and provides a level of security through its use in short distances and through its pairing function.

3.4. ATmega8 Microcontroller

The ATmega8 Microcontroller is interfaced with computing system and also home appliances. In the prototype five home appliances can be controlled. It is interfaced to computing system via USB to serial connection and it programmed respective to command received from computing system.

IV. IMPLEMENTATION AND WORKING

Objective of the proposed system is to build a prototype of user interactive Speech based HMI system which operates electronic devices in surrounding. Figure.2 shows the flow chart of proposed system which explains the implementation of system and the system works

The android mobile is used for speech recognition and software developed for application on the mobile device is coded in Java to recognize speech. In the proposed system we are using speech commands like “turn on light one”, “turn on TV” which can be configured according to user by modifying the MATLAB coded dictionary.

When speech is recognized it is transmitted to the computing system using the Bluetooth technology. Java Bluetooth API is used to communicate between application and Bluetooth module within phone. Another Bluetooth module is connected to computing system receives the input command and if MATLAB coded dictionary contains the input command then it instruct the ATmega8 to perform particular operation for particular device.

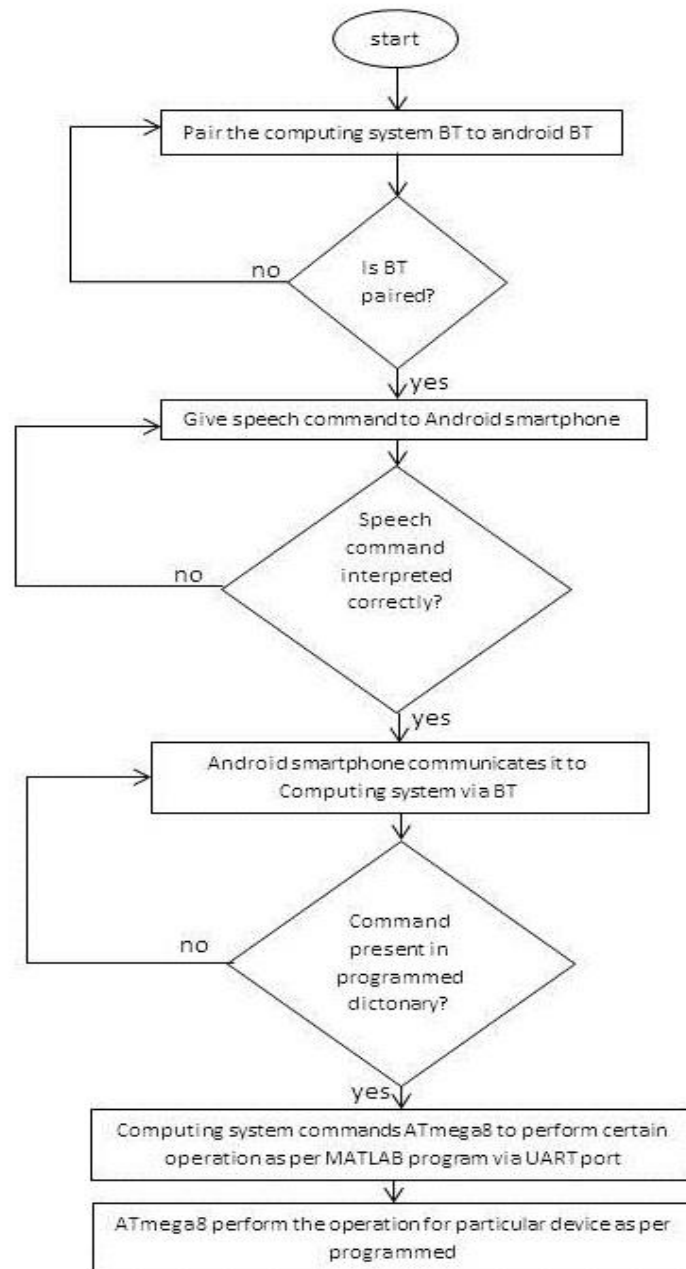


Figure.2 Flow chart of proposed system implementation

V. RESULTS AND DISCUSSION

- In **Figure 3**. Graphical user interface (GUI) coded in Matlab is shown while **Figure 4**. represents the prototype setup in running condition and the hardware implementation of proposed system.
- The system works very effectively and efficiently provided there is good Internet connection and user operates within Bluetooth range (10 meters).
- Few times app is unable to interpret speech because internet connection takes time for uploading and downloading. Also user has to pronounce the speech command loud and clear, android device misinterpret speech command if command is not pronounced clearly.
- If system doesn't operate as desired user can use manual mode to find if devices are properly interfaced or any device is faulty.
- The proposed system is more cost effective, more flexible and reliable, with less hardware and software complexity if compared with other available solutions like FPGA based HMI systems or completely microcontroller based HMI systems.

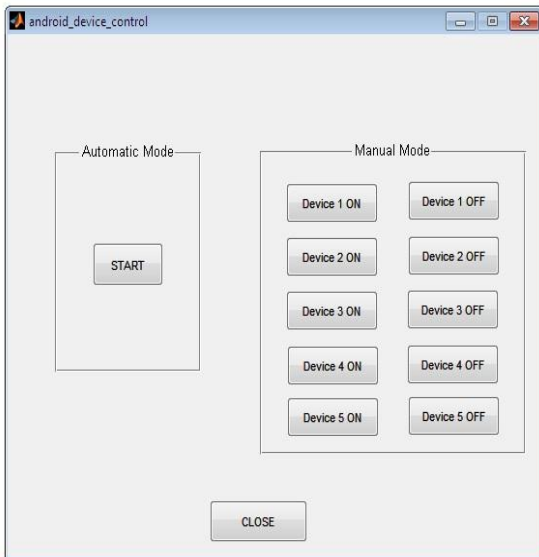


Figure 3. MATLAB coded GUI



Figure 4. Prototype setup

VI FUTURE SCOPE

In future, the proposed system will be modified to make the system more interactive and autonomous using methods like time monitoring and feedback to user. The system can also be interfaced with sensors so that system can perform actions on its own and interact with user intellectually to provide human like assistance to user.

VII CONCLUSION

The implementation of controlling home appliances by speech based Human Machine Interaction is achieved. The connection between computing system and ATmega8 microcontroller and also devices interfaced to the microcontroller can use either a wired connection or a wireless one, such as Zigbee or Infra-red. The implementation of proposed system is done by wired solution, however, the interface can be easily replaced by a wireless solution. Use of advance ATmega8 controller makes system scalable, while Matlab platform provides flexibility, reliability and lots of scope for future development. So the proposed speech based HMI system can work effectively and efficiently for real world applications.

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